

“Left ventricular” AV nodal reentrant tachycardia: Case report and review of the literature



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Introduction

Ablation failure is uncommon for typical slow-fast AV nodal reentrant tachycardia (AVNRT) and it is estimated that in <1% of cases, ablation in the left atrium is required to modify the circuit.¹ We report a case of typical AVNRT refractory to medical therapy and standard ablation approaches, that ultimately required ablation from the left ventricle to achieve noninducibility and clinical success. We present the relevant anatomy of the “left side” of the triangle of Koch and review the cumulative cases in the literature of left-sided ablation of AVNRT.

Case report

A 53-year-old woman with history of recurrent symptomatic supraventricular tachycardia status post previously failed AVNRT slow pathway modification catheter ablation presented to our center. The arrhythmia was refractory to escalating doses of beta-blockade, and during her initial procedure, ablation was abandoned owing to increasing proximity to the His bundle. She opted to proceed with repeat diagnostic electrophysiology study (EPS) and repeat ablation.

EPS demonstrated dual AV node physiology with easily inducible narrow complex tachycardia from high right atrium. Tachycardia cycle length (TCL) was 420 msec and earliest atrial activation seen at the His catheter with septal ventriculoatrial time <70 ms. The diagnosis of typical slow-fast AVNRT was confirmed based on a V-A-H-V response to overdrive pacing with corrected post-pacing interval TCL >110 ms (Figure 1A), nodal response to parahisian pacing and His-refractory premature ventricular contractions during tachycardia, and termination of tachycardia with a late premature atrial contraction.

KEYWORDS Ablation; Supraventricular tachycardia; AV nodal reentry (Heart Rhythm Case Reports 2016;2:367–371)

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Using a 4-mm nonirrigated ablation catheter (Blazer; Boston Scientific, Natick, MA), ablation was commenced at the level of the anterior portion of the coronary sinus (CS) os, gradually moving superiorly. Junctional beats were observed during radiofrequency delivery, although tachycardia remained inducible. Owing to low power (<20 W) observed on the majority of lesions that resulted in junctional rhythm, the ablation catheter was switched to an irrigation platform (ThermoCool SF; Biosense Webster, Diamond Bar, CA). Lower-power irrigated ablation (up-titrated from 10 W to 30 W) was performed to the CS roof, where junctional beats were reproducibly seen. Although the ease of inducibility was affected, the arrhythmia remained inducible. Given the extent of ablation (88 lesions total), the decision was made to discontinue the procedure to assess if any clinical improvement would result.

The patient was started on verapamil 120 mg daily, but palpitations recurred the following evening with near-incessant daily symptoms thereafter. She was consented for repeat ablation (her third overall) with the intention to pursue a left-sided approach or cryoablation at a site more proximal to the His. EPS again demonstrated easily inducible narrow complex tachycardia (TCL 460 ms) and maneuvers confirmed the same diagnosis.

Transseptal access was obtained under intracardiac echocardiographic guidance after heparinization. Using a 4-mm nonirrigated ablation catheter through a steerable sheath (Agilis; St. Jude Medical, Minneapolis, MN), ablation was performed at the left atrial septum overlying the inferoseptal mitral annulus initially targeting an atrial-to-ventricular ratio of 1:2–1:3 (Figure 1B). Owing to difficulty in achieving adequate power of >30 W, an irrigated catheter was used. Ablation was performed in regions of A:V signal ratio <1, with occasional junctional beats. Gradual progression to regions with a larger ventricular component (up to 1:5) over 27 radiofrequency applications remained ineffective (Figure 1B).

The ablation catheter was withdrawn from the left atrium and repositioned in the right atrium at the anterior portion of the CS roof, where consistent accelerated junctional rhythm

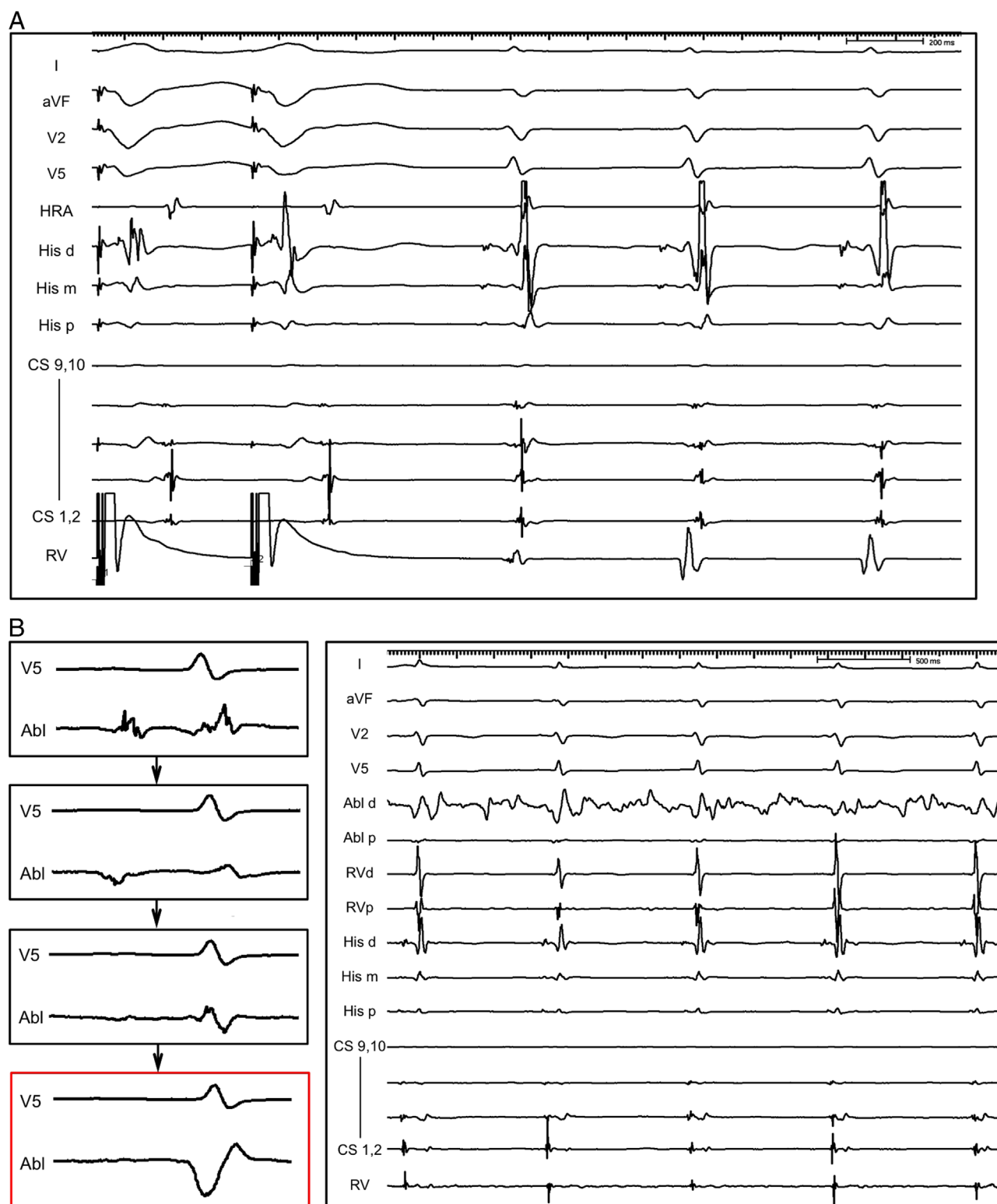


Figure 1 (A) Intracardiac recordings of typical AV nodal reentrant tachycardia with response to overdrive pacing demonstrating ventriculoatrial time <70 ms and post-pacing interval tachycardia cycle length >110 ms. (B) Progression of radiofrequency applications from the left side starting with 1:1 AV ratio until the successful site (red) with ventricular electrogram. Consistent accelerated junctional rhythm was seen during ablation multiple times.

was observed, although tachycardia remained inducible. The irrigated catheter was then repositioned in the left atrium to the region directly across the right-sided CS roof site with consistent junctional rhythm during ablation. CS venography

was performed confirming the position of the ablation catheter overlying the proximal CS. On right anterior oblique view, the catheter was prolapsed into the ventricle, anterior to the His catheter. The local signal demonstrated a ventricular

KEY TEACHING POINTS

- Ablation failure with AV nodal reentry is uncommon and a left-sided approach is useful for refractory cases.
- The anatomic relationship between the right and left side of the septum is dictated by the offset between the tricuspid and mitral annulus.
- Ventricular ablation may be necessary in rare cases to perform slow pathway modification in the left-sided variant of AV nodal reentry.

electrogram with a trace far-field atrial component. Ablation at this site resulted in a consistent accelerated junctional rhythm (Figure 1B). AVNRT was inducible and an additional ablation terminated AVNRT. Three additional lesions (50 W for 60 seconds, temperature limit 42 W) were applied at this ventricular site and tachycardia was rendered non-inducible. She has remained free of arrhythmia recurrence 6 months after her procedure off all medications.

Discussion

We present this case to illustrate the following:

- (1) A left-sided approach is infrequently required but may be highly effective for patients with failed AVNRT ablation via traditional approaches.
- (2) Owing to relative inferior displacement of the tricuspid valve, the relevant anatomy of the left side of the triangle of Koch results in a larger ventricular component than the traditional right-sided sites directly opposite the septum.

To the best of our knowledge, this is the first case demonstrating successful ablation of typical AVNRT from

within the left ventricle, after sites on the left atrial side of the annulus proved to be ineffective. Review of the literature reveals 14 case reports describing a combined 37 cases of typical slow-fast AVNRT necessitating left-sided ablation over a 20-year period (Table 1). Through a variety of approaches including transseptal, retrograde, or via CS, junctional beats were uniformly seen in the cases reported, with excellent success rates. The targeted atrial-to-ventricular ratio ranged around 1:2, with the lowest ratio of 1:8 reported by Jais et al.² The extent of ablation required in this patient was atypical compared with the reported cases, although sites with larger atrial components were first attempted systematically.

Eccentric atrial activation of the CS owing to leftward extensions of the slow pathway was first systematically reported by Hwang et al in 1997.³ While right inferior and left inferior extensions of the slow pathway have been well described,⁴ the incidence of “left atrial” AVNRT is estimated at <1%.¹ In the case of typical AVNRT, mapping of the atrial extensions is clinically difficult, as retrograde activation occurs over the fast pathway and retrograde jump is not as frequently seen with extrastimulus testing.

Owing to the inferior displacement of the tricuspid valve relative to the mitral valve (Figure 2), the posterior superior process of the left ventricle shares a common portion of the septum with the right atrium. In the present case, left-sided ablation at the site in closest proximity to the right-sided CS ostium was achieved in a left ventricular location below the mitral annulus. The offset between the tricuspid and mitral valve dictates that the corresponding left-sided site across a 1:3 ratio in the triangle of Koch would be expected to have a larger ventricular component. Although multiple ablations in this region may diminish the local atrial electrogram amplitude, yielding a lower A:V ratio, the anatomic fluoroscopic relationship is consistent with a site on the ventricular side of the mitral annulus.

The unusual form of ventricular septal defect from the left ventricle to the right atrium, called a Gerbode defect,⁵

Table 1 Summary of literature reporting ablation of AV nodal reentrant tachycardia with left-sided approach

Authors	Year	AVNRT Type	N	Approach	Anatomic Site	A:V Ratio	Junctionals	RF	Recurrence
Hwang et al ³	1997	11 SS, 9 FS	20	CS	Outside CS	—	—	—	—
Jais et al ²	1999	1 SF	1	RT	LA endo	0.125	Yes	—	No
Sorbera et al ⁷	2000	3 SF, 2 FS	3	TS	LA endo	0.4, 0.5	Yes	—	No
Altemose et al ⁸	2000	1 SF	1	TS	LA endo	—	Yes	1	No
Kobza et al ⁹	2005	1 SF	1	TS	LA endo	<0.5	Yes	—	No
Kilic et al ¹⁰	2005	9 SF	9	RT	LA endo	<0.5	Yes	—	No
Otomo et al ¹¹	2006	5 SS, 3 FS	8	CS	Inside CS	—	Yes	3 ± 2	No
Otomo et al ¹²	2007	12 SS, 11 FS	18	CS	Inside CS	1.6 ± 1.2	Yes	4 ± 3	5%
Jorat et al ¹³	2007	1 SS, 1 SF	2	TS, RT	LA endo	<0.5	Yes	—	No
Yamabe et al ¹⁴	2010	4 FS	1	TS	LA endo, CS os	—	—	—	—
Katrisis ¹⁵	2010	1 SF	1	TS, RT	LA endo	—	Yes	—	No
Stoyanov et al ¹⁶	2010	1 SF	1	TS	LA endo	>0.5	Yes	—	No
Katrisis et al ¹⁷	2011	4 SF	4	TS, RT	LA endo	<1	Yes	5.5–7.8	No
Otomo et al ¹⁸	2014	5 SF	5	TS	LA endo	—	Yes	—	20%

AVNRT = AV nodal reentrant tachycardia; CS = coronary sinus; endo = endocardial; LA = left atrial; RF = radiofrequency; RT = retrograde; TS = transseptal.

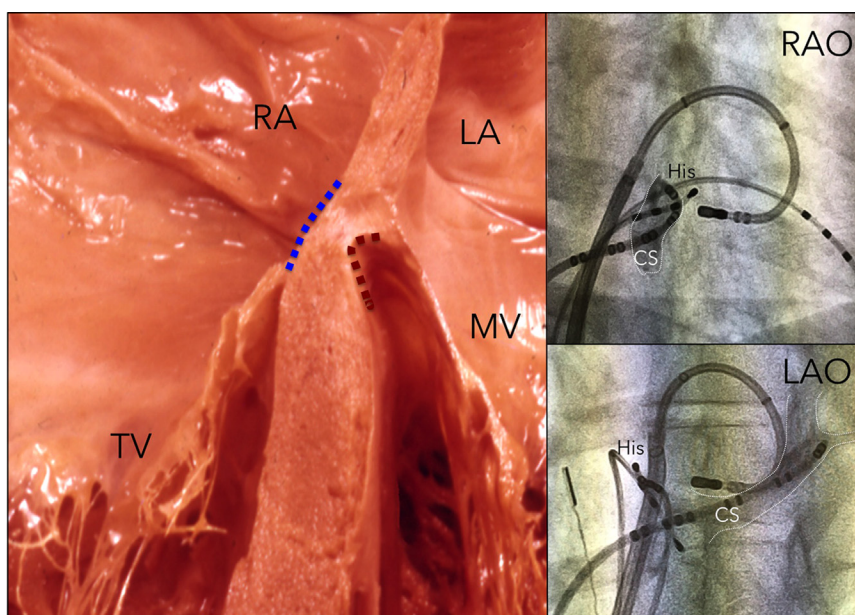


Figure 2 Anatomic relationship of the inferiorly displaced tricuspid valve (TV) relative to the mitral annulus. The right atrial (RA) portion of the slow pathway target zone is shown with blue line and the corresponding left ventricular portion is shown with red line. Fluoroscopic views demonstrate the ablation site anterior to the His on right anterior oblique (RAO) and at the inferoseptal mitral annulus on left anterior oblique (LAO). Wallace A. McAlpine Library, Courtesy of UCLA Cardiac Arrhythmia Center. CS = coronary sinus; LA = left atrium; MV = mitral valve.

highlights this anatomic relationship, where the opposite side of an atrial region may indeed be the contralateral ventricle, and vice versa (Figure 3). This region of the heart is relevant

to catheter ablation of ventricular tachycardia from the posterior superior process of the left ventricle, which has been achieved from the right atrium.⁶

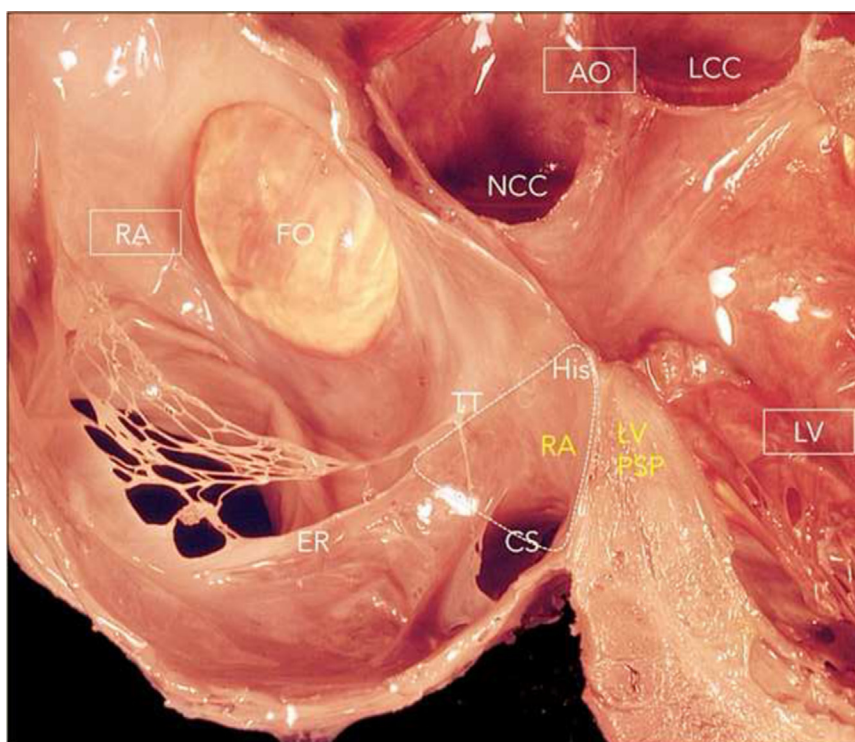


Figure 3 Anatomic view from the tricuspid valve perspective showing the relationship between the triangle of Koch (dashed line) in the right atrium (RA) and the posterior superior process (PSP) of the left ventricle. AO = aorta; CS = coronary sinus; ER = Eustachian ridge; FO = fossa ovalis; LCC = left coronary cusp; NCC = noncoronary cusp; TT = tendon of Todaro. Wallace A. McAlpine Library, Courtesy of UCLA Cardiac Arrhythmia Center.

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